PREPARATION AND EVALUATION OF NANOFIBROUS MATERIALS AND THEIR USE IN WASTE WATER TREATMENT

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Nanomaterials have attracted great attention in diverse areas because of their unique properties. One of the possible nanofiber applications, due to their high surface area, is a biomass carrier, thus the immobilization of the microbial cells followed by the biofilm formation. Because the microbial colonization and biofilm functionality on the nanofiber surface are influenced by the characteristics of the nanofiber carriers, it is possible to create a specific environment for bacteria by setting various parameters of the nanofiber preparation, such as material, modification and surface structure.

The aim of this work is to examine the characteristics of nanofibers prepared by different electrospinning techniques and evaluate them for the application in the biological wastewater treatment. Two types of polymer, polyurethane and polyvinyl butyral, were used for nanofiber production. In total, five electrospinning techniques were employed for nanofiber preparation: alternating current (AC) electrospinning, direct current (DC) rod electrospinning, DC single-needle electrospinning, DC needleless electrospinning Nanospider™ technology and electro-centrifugal spinning. The morphology and structural analysis of prepared nanofibers, including the surface roughness, was performed using a scanning electron microscopy (SEM) and confocal microscopy. The biodegradation of nanofibers was assessed using standardized respirometric tests. Based on the analysis results, the most suitable nanofiber material for biological applications was determined – polyvinyl butyral prepared using Nanospider technology, which was subsequently tested in a biological laboratory reactor as a biomass carrier. The nitrification process and nitrifying bacteria in the bioreactor were monitored using respirometry and molecular-genetic methods, specifically, FISH analysis and real-time qPCR analysis. Additionally, the applicability of nanofiber carriers was evaluated for the biological wastewater treatment. The results of the analyzes show that the chosen PVB carrier significantly supported the growth of biomass, where a significant proportion of nitrifying bacteria was found using molecular genetic methods. In addition, the chemistry of the reactor during the experiment confirmed the high efficiency of the nitrification process.